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(71) Applicant: **MARITIME HYDRAULICS A.S.**
Dvergsnes
N-4604 Kristiansand (NO)

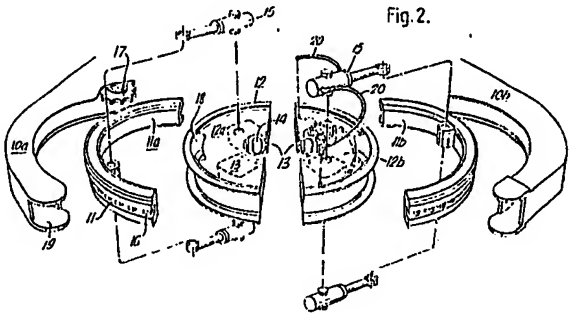
(72) Inventor: **Vatne Per**
Gudbrandsila 4a, Som
N-4600 Kristiansand S (NO)

(74) Representative: **Hellborg, Torild et al**
H. ALBIHNS PATENTBYRA AB P.O. Box 3137
S-103 62 Stockholm (SE)

(54) A torque wrench.

(57) A torque wrench comprises a split casing (10) which can be divided to receive and grip pipes, each casing half (10a,10b) comprising jaws (14) which are synchronously movable to center and frictionally engage the pipe joints. The wrench has a split inner annulus (12a,12b) which is mounted in and connected to a split intermediate annulus (11a,11b) which is rotatably mounted in the split casing (10). Inner annulus (12) is provided with at least two activable and displaceable clamping jaws (14) and furthermore, means are (21,22,23,16) provided for temporary and external transfer of a controlled torque to intermediate annulus (11). The torque is, in turn, transferred to inner annulus (12) by the aid of a connection (15), preferably in the shape of pump cylinders, which at the same time activate and provide the displaceable clamping jaws (14) with the necessary power. With the spinning motor (25) the wrench forms a combined spinning and torque wrench (2). With a back-up wrench means (3), and mounted on a carriage (4) the wrench means forming a complete roughneck (1).

Fig. 2.



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Description

A TORQUE WRENCH

The invention relates to a torque wrench for tightening and braking out threaded joints between drill pipe and drill collar sections forming parts of a drill string.

The background of the present invention is problems and the amount of work needed related to inserting and unscrewing drill pipes on the drill floor during drilling operations, particularly with regard to inserting and removing a drill string into/from a drilling well in a tripping operation.

During the last 10 to 20 years hydraulic/mechanical equipment was available to facilitate such operations. Equipment of this kind is called a roughneck, and one concept is shown in US-PS No. 4 348 920. In short, such a roughneck comprises a two-piece lower unit the lowermost member of which forms back-up wrenches, whereas the upper member acts as a torque tong or wrench. Said wrench enclasp a drill pipe joint, and in a conventional drilling operation the back-up wrenches will clasp the sleeve portion of the joint, and the torque wrench will clasp the tap portion of the joint. The wrench cause the final torque make up, or breaking out, respectively, between pipe sections, whereas upper spinning means causes the pipe sections to be screwed in, or unscrewed, respectively. A similar concept is shown in US-PS No. 4 603464.

Existing equipment is, obviously, limited as regards flexibility in case of changed diameters or dimensions. A drill string may comprise drill pipes having a diameter of 3,5" with a joint diameter of 4.5", and drill collars with diameters up to 9.5". With existing equipment it is common practice to replace jaws in the gripping jaws of tongs at least once, may be twice, to accomodate diameter variations. Also, many tools lack capacity for the largest diameters.

According to the invention a torque wrench is achieved which is flexible as regards various pipe dimensions or pipe diameters, and it is able to accomodate, e.g. the range from 3.5" drill pipes to 9.5" drill collars. Aditionally, it contributes to autocentering the pipes in the wrench means. As distinct from previous concepts the present torque wrenche adapts the clamping moment to the pipe diameter. Thus, the pipe joints are spared, resulting in a longer life of the drill pipes. The structural design of the torque wrenches ensures a self-tightening effect of the jaws, resulting in a good and rellable frictional engagement between jaws and drill pipes all over the range of pipe dimensions. The device according to the invention also permits combination of the torque wrench with a spinning means into one unit. Combined with back-up wrenches, and mounted on a carriage, this will provide a less complicated bulld-up with fewer parts and a lower weight of the complete roughneck.

With conventional separate spinning and torque wrenches equipment said components or units must be operated by the aid of separate control levers. Since each unit has several functions, e.g. clamping, spinning, opening spinning means, and closing, clamping, twisting, and opening torque wrenches, the operator will have to execute a large number of functions in each operation.

In a combined spinning and torque wrench the number of functions to be carried out by the operator is minimized, torque tightening being a direct continuation of the spinning movement, and it will, consequently, be possible to operate with one lever.

According to the invention the above advantages are achieved by a torque wrench of the kind mentioned above comprising a split casing which may be separated to enclose pipes. Each casing half comprises jaws which are synchronously movable for centering and frictional engagement with the pipe sections. The device is characterized by the fact that said wrenches comprises a split internal annulus which is mounted in and connected with a split intermediate annulus, which is rotatably mounted in said split casing, that said inner annulus is provided with at least two activable and displaceable clamping jaws and that means are provided and temporary andexternal transmission of a controlled angular movement to the internediate annulus said angular movement, in turn, being transmitted to the inner annulus by the aid of said connection, the latter at the same time activating and tightening the displaceable clamping jaws with necessary force.
Advantageously, friction generating means are provided temporarily to restrain any relative movement between inner annulus and casing.
Conncetion between inner annulus and intermediate annulus may be achieved by the aid of at least one tangentially arranged and tangentially acting pump cylinder. Each pump cylinder is, preferably, hydraulic and in hydraulic communication with hydraulic radially acting clamping jaws. The clamping jaws may suitably be provided in elongated guiding cylinders to provide control and a firm grip of the jaws over the whole range of pipe diameters. Each pump cylinder may advantageously be double-acting and in connection with one hydraulic and two-directional clamping jaw via respective hydraulic circuits.
The intermediate annulus may advantageously comprise means for an operative connection with a spinner motor for controlled rotation of intermediate annulus and the connected inner annulus in order to form a combined spinning and torque wrench.

The wrench may suitably comprise a separate back-up wrench provided below and, correspondingly, belng intended for gripping pipes of various dimensions, with one or both wrenches being substantially movable vertically along guides.

The spinning and torque wrench and the back-up wrench means are suitably provided on a carriage with one or both tongs means being substantially movable in a vertical direction along common guides provided on the carriage to form a complete roughneck.

Further objects, features, and advantages will appear from the following disclosure of an embodi-

ment of the invention which is at present preferred and is described with reference to the attached drawings to illustrate the invention.

Figure 1 is a diagrammatic top view of the torque tongs or wrench device according to the invention,

Figure 2 is a perspective view of the front portion of the torque tongs device according to the invention,

Figure 3 is a diagrammatic view of the mode of operation of the tongs device,

Figure 4 is a diagrammatic view of a back-up tongs means, commonly mounted below the torque tongs device,

Figure 5 is a diagrammatic side elevation of a complete roughneck comprising the torque tongs device, the spinning means, and the back-up tongs means,

Figure 6 is a diagrammatic front view of the roughneck according to Figure 5.

Figures 5 and 6 show a complete roughneck 1 with torque tongs device 2 forming a device control unit, and with a back-up tongs means 3 forming another device control unit. Both tongs are mounted on a carriage 4 provided with wheels for displacement, e.g. on a drill floor 7. Carriage 4 may be provided with wheels intended for movement on rails which are, in turn, mounted on drill floor 7. Vertically extending guides 5 are mounted on carriage 4 for controlled independent movement of torque tongs means 2, and back-up tongs means 3, respectively. As mentioned, complete roughneck 1 is intended for joining, tightening, breaking out, and unscrewing operations on pipe sections 6 by gripping sleeve and tap members 8, respectively.

In a top view in Figure 1 the torque tongs device is shown in more detail. The shown torque tongs device comprises a motor 25 for rotation of a portion of said tongs means to screw together pipe joints. When the torque tongs device is provided with such a spinning motor it consitutes a spinning and torque tongs device 3. The tongs means comprises a casing 10 which is split into two halves 10a, and 10b, respectively. Casing halves 10a, 10b can be locked together by the aid of a locking means 26 which is provided on the front edge of casing 10. Casing 10 can be split along its axis of division 50 so as to receive pipe sections in the tongs means. Each casing half 10a, 10b is swingable or pivoted about a common shaft 24. A fluid power cylinder 31 operates an opening and closing mechanism 25. The shown torque tongs means is also provided with sleeve guides 32 for slidable cooperation with guides 5 on carriage 4.

The rotatable portion of the torque tongs device is shown in more detail in Figure 2. The stationary portion of the tongs consists of casing halves 10a, 10b. The rotatable portions of the tongs device comprise an inner annulus 12, and an intermediate annulus 11. Intermediate annulus 11 is composed of two halves 11a and 11b. Correspondingly, inner annulus 12 is composed of two halves 12a and 12b. Inner annulus 12 is mounted in intermediate annulus 11 by the aid of a bearing. Intermediate annulus 11 is, in turn, mounted in casing 10. The bearings may be of any suitable kind, e.g. ball bearings, roller bearings, and slide bearings. The bearings may be removable, or they may form part of components. The bearing material may, e.g. be sprayed directly onto the portions that are movable relative to each other. It should be mentioned in this connection that movement between inner annulus 12 and intermediate annulus 11 will only occur along a small curved angular segment and will hardly create much wear. Essential rotation and relative movement will occur between intermediate annulus 11 and casing 10.

In the shown embodiment intermediate annulus 11 is provided with bolts forming a tooth structure 16 for operative engagement with a gear 17 which is arranged on spinning motor 25. Spinning motor 25 may be of any desired kind, e.g. a hydraulic motor. Besides being mounted in intermediate annulus 11 the inner annulus 12 is connected with intermediate annulus 11 via pump cylinders 15. Pump cylinders 15 may be pneumatic, but are, preferably, hydraulic. Pump cylinders 15 are at one end connected with intermediate annulus 11 by the aid of, e.g. pivots (not shown). At the other end pump cylinders 15 are rotatably attached to inner annulus 12. The piston rod of pump cylinder 15 is suitably, but not necessarily, attached to intermediate annulus 11, and the casing of pump cylinder 15 is pivotally connected with inner annulus 12. Inner annulus 12 also comprises clamping cylinders 13 which are secured to inner annulus 12. Each inner annulus half 12a and 12b must have at least one such clamping cylinder 13. Even though the shown embodiment is provided with four clamping cylinders 13 any number of clamping cylinders from two upwards may be used. Clamping cylinders 13 control activable and displaceable clamping jaws intended for engagement with pipe joints. Pump cylinders 15 are connected with clamping cylinders 13 via pneumatic or hydraulic circuits 20, which constitute hoses in the shown embodiment. In stead of using hoses 20 channels may be drilled in the inner annulus 12. It should be observed that said pneumatic or hydraulic circuits are closed circuits, thus, there is no transmission of fluid between casing 10 and intermediate annulus 11 or inner annulus 12.

As shown, casing 10 as well as inner annulus 12 and intermediate annulus 11 are divided and may be split to receive a drill pipe. When the tongs device is to be split, intermediate annulus 11 and inner annulus 12 must, consequently, be in such a position relative to casing 10 that their respective division lines coincide with the division line or axis 50 of the casing. As shown in Figure 1, a psitioning valve 28 is provided to be activated mechanically, e.g. by projections on the intermediate and inner annulus. Whenever intermediate annulus and inner annulus are not within this area the tongs cannot be split. In which casing half the respective annulus halves are present is of no consequence so that the maximum rotation of rings 11,12 before they split is 180°. On the face of division between inermediate annulus halves 11a, 11b guides are preferably provided, e.g. pin and aperture (not shown). Corresponding guide pins and apertures may advantageously be provided on the faces of division of inner annulus halves 12a

and 12b, respectively. As shown in the Figure, inner annulus 12 is also provided with recesses 18 for the pivot between intermediate annulus 11 and pump cylinder 15 to permit relative angular turning between intermediate annulus 11 and inner annulus 12.

A working cylinder 21 is mounted on casing 10 and intended to transmit the turning moment to intermediate annulus 11 to be transmitted to inner annulus 12. Said working cylinder may be hydraulic, pneumatic, or mechanic and will act as a linear motor. Piston rod 33 of working cylinder 21 is rotatably connected with a displaceable casing 22 which is slidably mounted in casing 10. When working cylinder 21 is activated sliding casing 22 describes a circular arch and will normally span a sector of 30°. Inside sliding casing 22 a pawl 23 is journalled in a pivot 34. When working cylinder 22 is in a retracted position, i.e. when piston rod 33 is totally retracted into working cylinder 21, pawl 23 is in a "resting position". When cylinder 21 is activated a mechanism will cause pawl 23 to turn about pivot 34 until a nose member on the pawl contacts the inside of sliding casing 22. At the same time a hook member 36 on pawl 23 engages the bolt tooth means and will cause rotation of inner annulus 11 when piston rod 33 is further extended, so that a moment of rotation is transmitted to inner annulus 11. As soon as the piston rod is retracted into working cylinder 21, e.g. a spring mechanism will turn pawl 23 back into its starting position. If necessary, working cylinder 21 can make a number of strokes to achieve the necessary moment. In the shown embodiment pawl 23 acts on the same bolt tooth arrangement as spinning motor 25. These transfers, however, may be separate and could be achieved in a different manner, e.g. by the aid of a conventional gear rim.

As shown in Figure 1, the torque tongs means can, advantageously, also be provided with a friction generating means 30, e.g. corresponding to the conventional disk brake. In the shown embodiment a caliper casing is secured to casing 10 of the torque tongs device, where activable frictional linings are intended to cooperate with a braking disk (not shown) that is secured to inner annulus 12. The function of friction means 30 will be disclosed in more detail below.

Figure 3 shows a diagrammatical view of the torque tongs device which will illustrate more clearly how the tongs device operates as well as its performance. Split inner annulus 12 is provided with four cylinders 13, each receiving a clamping jaw. Clamping jaws 14 are movable in cylinders 13 and provide a tongs device which is flexible as regards the dimensions of drill pipes. Normally, the tongs device may be used for pipe dimensions from 3.5" drill pipe to 9.5" drill collar. However, this range may be enlarged without special difficulties. Each cylinder 13 is connected with a pump cylinder 15, via a hydraulic circuit. Between inner annulus 12 and intermediate annulus 11 a slight relative angular movement is possible. When a pipe section 6 is gripped by the torque tongs deivce brake means 30 is activated to hold inner annulus 12 temporarily. Then intermediate annulus 11 is turned, the turning moment is, in turn, transmitted, via piston rods in pump cylinders 15, to activate the inner and closed hydraulic circuit. Thus, the pressure is transmitted to cylinders 13 and clamping jaws 14. The clamping jaws are displaced radially towards drill pipe 6 to center the pipe. In the Figure four separate independent hydraulic circuits are shown, but in other embodiments one single pump cylinder 15 may activate two or all jaws in an inner annulus half 12a, 12b. Now, break means 30 is released, and motor 25 spins intermediate annulus 11, inner annulus 12 with jaws 14, and the pipe section 6 as one single unit into a lower socket joint end 8 of a pipe section. When the pin end of the joint is spun into the socket of sleeve portion of the joint by the aid of spinning motor 25, when commonly contributes with a tightening moment in the order of 7 kNm, the final moment is made up by pressure in working cylinder 21 which is transmitted to inner annulus 11, via pawl 23. The pressure applied to working cylinder 21 has to be adjusted in accordance with the pipe diameter present in the tongs device.

The geometry of the connection between inner annulus 11 and intermediate annulus 12 should be noted. The connection is provided by pump cylinders 15. The line of action of cylinders 15 is especially notable. In case of large pipe diameters the lines of action of pump cylinders 15 will be tangential with relative large circles about the centre of pipe. In case of smaller pipe dimensions the line of action of cylinder 18 will be tangential with circles about the centre of pipe of smaller diameters, or, as shown in the Figure, pump cylinders 15 will move into a more radial position. As known, various tightening moments are required for various pipe dimensions, with the largest pipe dimensions requiring the largest tightening moment. It is, e.g. common to tighten conventional 3.5" drill pipes by 10 kNm, and large drill collars of 9.5" by 120-150 kNm. The shown concept permits the operator to adjust the clamping force of jaws 14 in a comparatively simple manner by the aid of the pressure applied to working cylinder 21. The geometry of the structure, indeed, ensures that the necessary force is achieved. In case of small pipe dimensions the line of action of pump cylinders 15 is more radial, which would, in case of a constant turning moment of intermediate annulus 11, cause considerably higher radial forces in clamping jaws 14 than in case of large pipe dimensions. But small pipe dimensions do in fact require a lower tightening moment and, consequently, working cylinder 21 should apply a lower turning moment to inner annulus 11. This lower turning moment, in turn, will cause a lower pressure in the inner circuits 20. Correspondingly, pressure in jaws 14 will decrease in case of increasing pipe diameters since pump cylinders 15 move to a tangential position in increasing circles about the pipe centre. This is compensated by an increased pressure applied to working cylinder 21 so as to provide for a sufficient turning moment on intermediate annulus 11 and, consequently, an tightening torque to pipe joint 8. According to the above mentioned, the tightening moment may readily be adapted to various pipe dimensions, and that goes for clamping forces applied by jaws 14 to pipe joint 8

as well. Thus, the working surfaces of the pipe joints are spared in a much better manner than previously possible.

Figure 4 is a diagrammatic view of a back-up tongs means which, indeed, can be of any suitable known kind, but is, advantageously of a dimension flexible kind. The shown tongs means is of a kind having a constant opening and is, thus, not a split kind. Three cylinders with associated clamping jaws are shown, but any suitable number of cylinders may be used. The back-up tongs means is vertically movable in relation to the torque tongs device, preferably along the same guides 5 as used by torque tongs device 2.

Each cylinder 13 holding and guiding the clamping jaws 14 is of a kind known per se and is not disclosed in detail. It should, however, be mentioned that they are of a certain length to be flexible in relation to the intended range of dimensions at the same time as they ensure good lateral support and guidance within their entire operative range of movement.

Claims

1. A torque wrench for tightening and breaking out threaded joints (8) between drill and tool pipe sections (6), comprising a split casing (10) separatable to receive and embrace pipes, each casing half (10a,10b) includes jaws (14) which are synchronously movable for centering and frictional engagement with said pipe joints, wherein said wrench comprises a split inner annulus (12a,12b) which is mounted in and connected (15) with a split intermediate annulus (11a,11b) which is rotatably mounted in splitable casing (10), said inner annulus (12) being provided with at least two actuatable and displaceable clamping jaws (14), and means (21,22,23,16) provided for temporary and external transmission of a controllable turning moment to intermediate annulus (11), which turning moment is, in turn, transmitted to inner annulus (12) by the aid of said connection (15), said connection (15) at the same time actuates and supplies the displaceable clamping jaws (14) with the required power.

2. A torque wrench as defined in claim 1, **characterized in** that it comprises friction generating means (30) in order to restrict temporarily any relative movement between inner annulus and casing (10).

3. A torque wrench as defined in claims 1-2, **characterized in** that said connection (15) between inner annulus (12) and intermediate annulus (11) is provided by at least one tangentially arranged and acting pump cylinder.

4. A torque wrench as defined in claim 1-3, **characterized in** that each pump cylinder (15) is hydraulic and has a hydraulic connection (20) with hydraulically operable and radially acting clamping jaws (14).

5. A torque wrench as defined in claim 4, **characterized in** that clamping jaws (14) are arranged in elongated guiding cylinders (13) providing good control and guidance for the jaws all over the range of pipe diameters.

6. A torque wrench as defined in claims 1-4, **characterized in** that each said pump cylinder is double acting and connected with a respective hydraulic and two-way operative clamping jaw (14), via respective hydraulic circuits (20).

7. A torque wrench as defined in claim1 1-6, **characterized in** that the wrench is turnable 360° about its axis (50).

8. A torque wrench as defined in claims 1-7, **characterized in** that said intermediate annulus (11) comprises means (16) for operating connection with a spinning motor (25) for controlled rotation of intermediate annulus (11) and said associated inner annulus (12) to form a combined spinning and torque wrench device (2).

9. A torque wrench as defined in claims 1-7 or 8, **characterized in** that it comprises a separate lower back-up wrench (3) correspondingly intended to grip pipes of various dimensions, with one or both wrenches being substantially movable vertically along guides (5).

10. A torque wrench as defined in claim 9, **characterized in** that spinning and torque wrenches (2) and back-up wrenches (3) are provided on a carriage (4) with one or both wrenches being substantially movable vertically along common guides (5) provided on carriage (4) forming a complete roughneck (1).

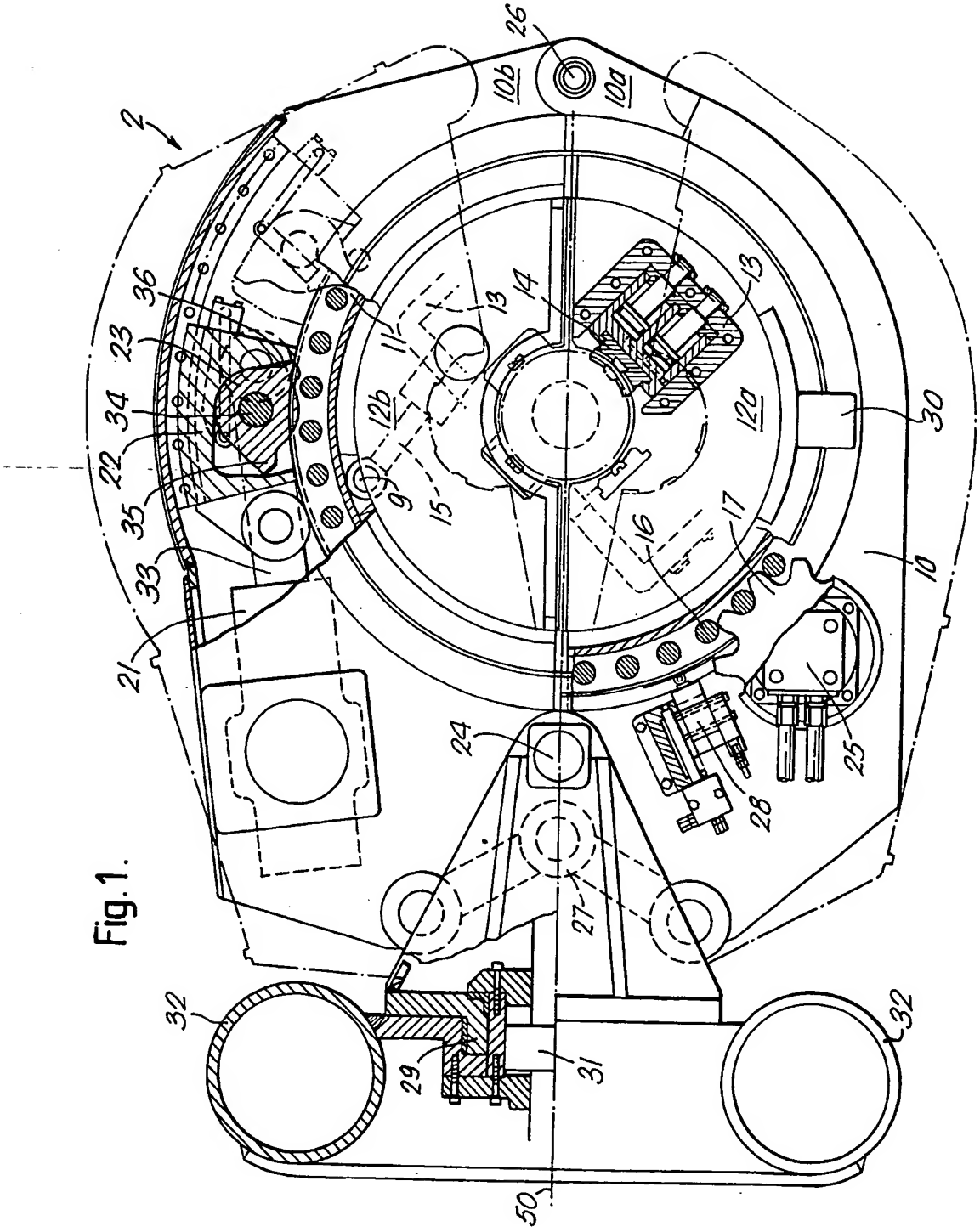
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Fig. 1.

Fig. 2.

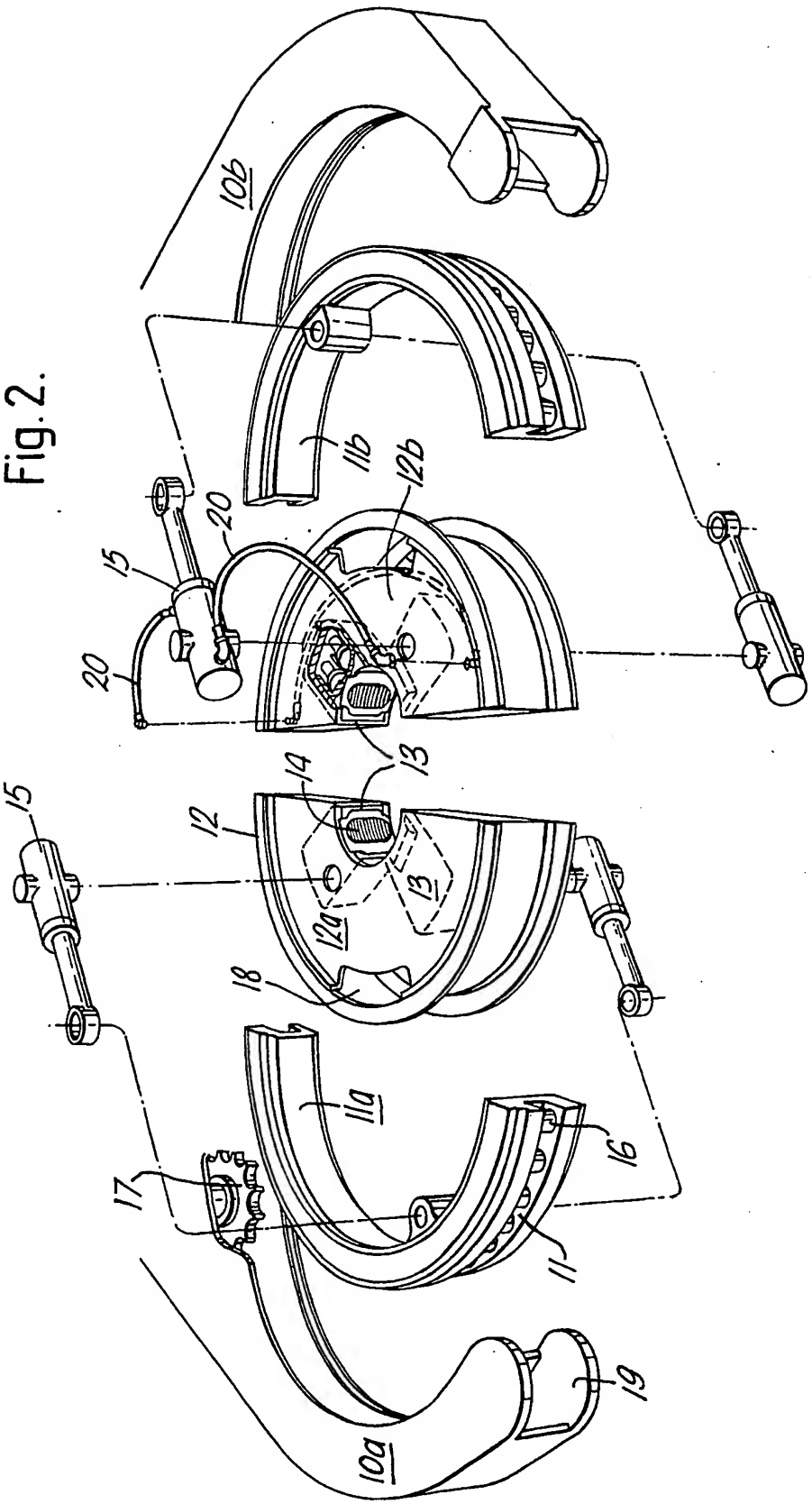
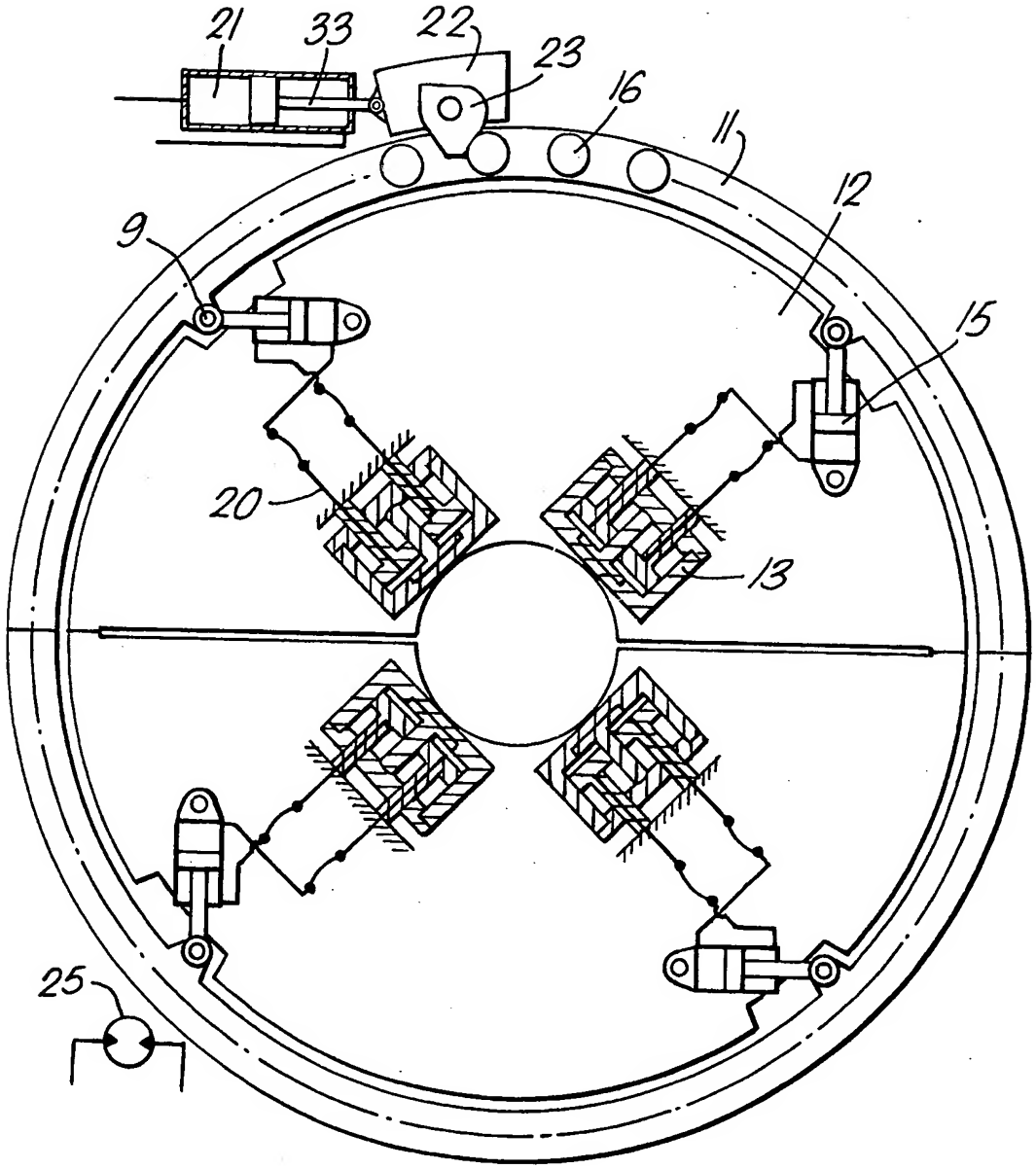


Fig.3.



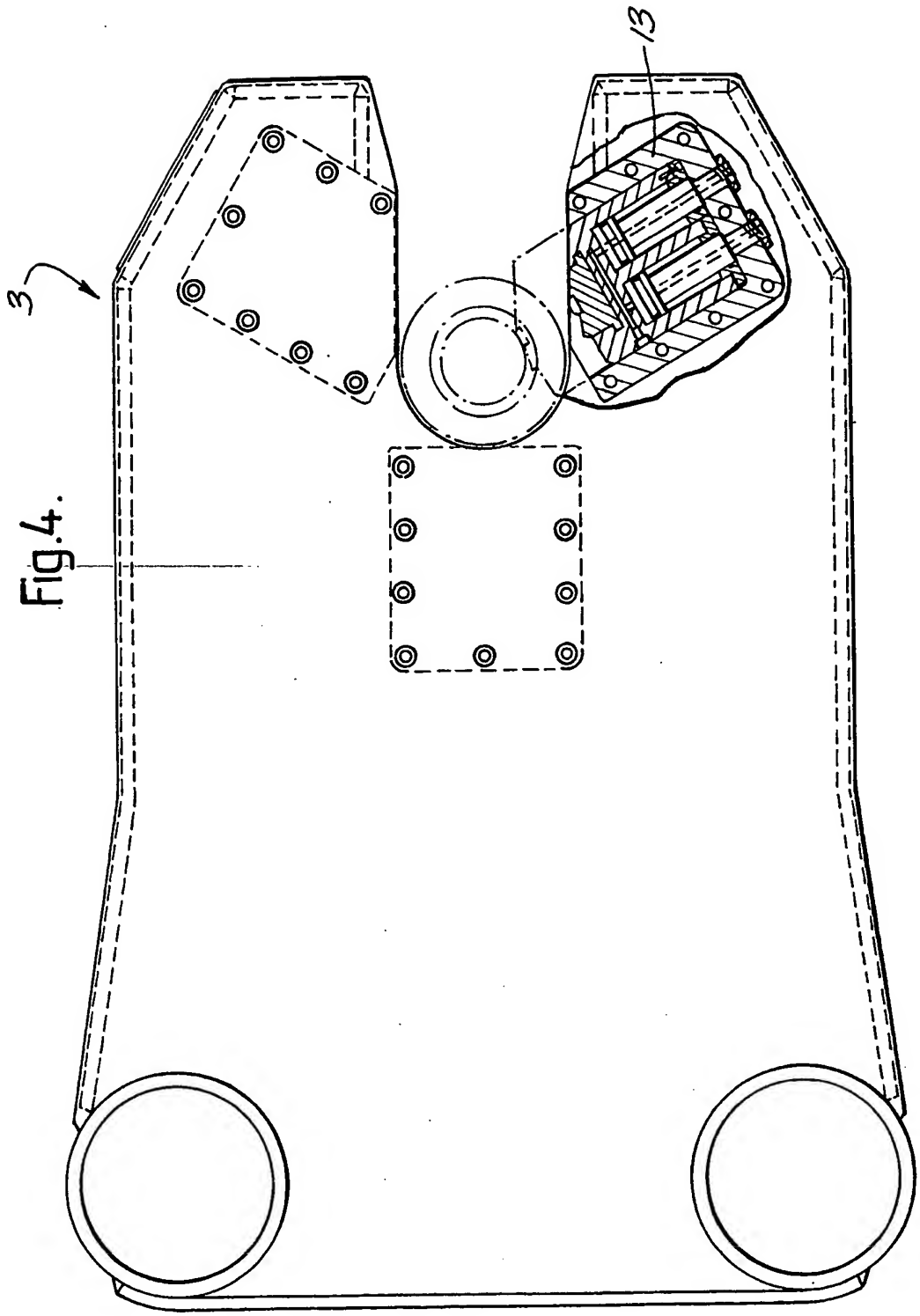


Fig.4.

Fig.5.

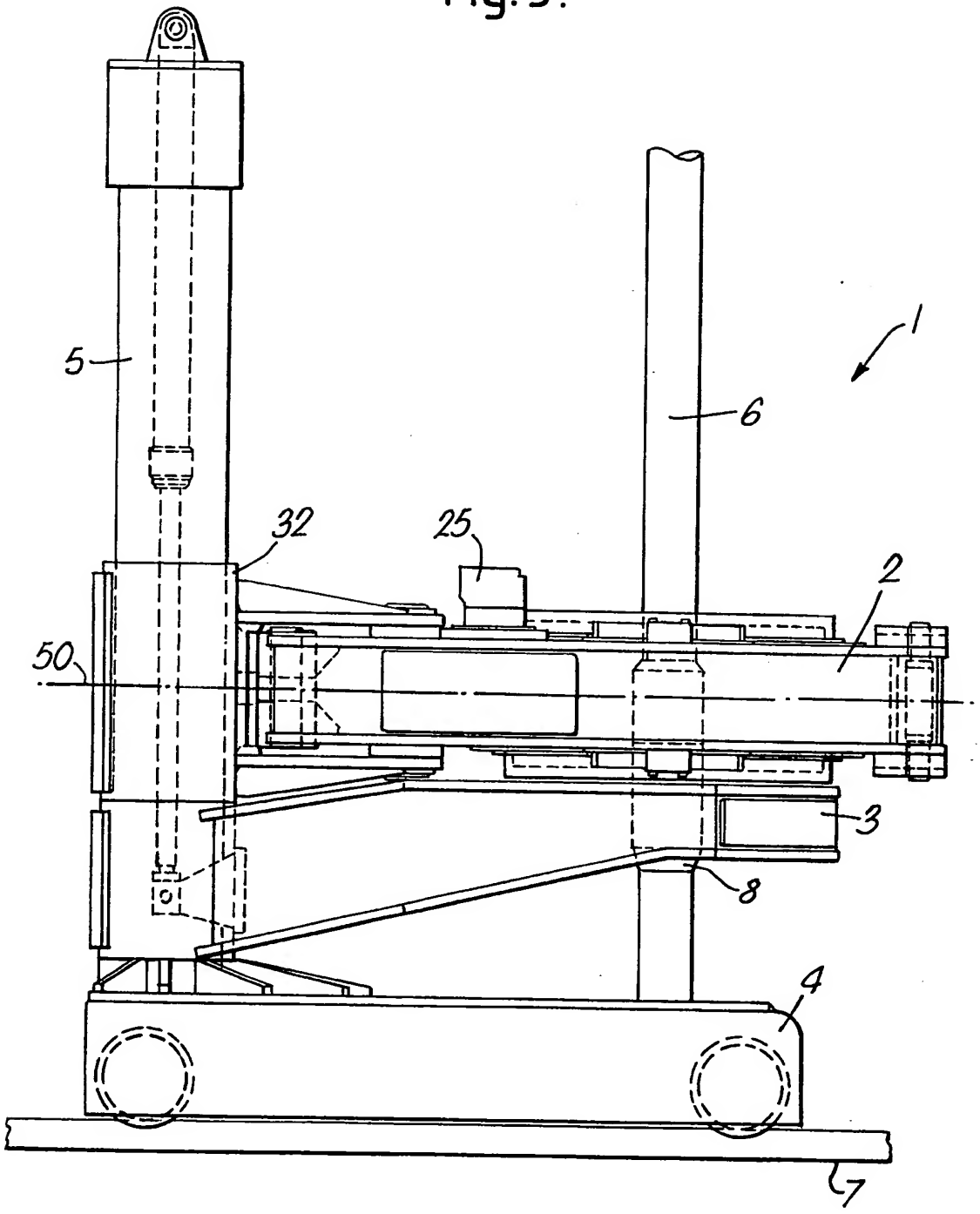
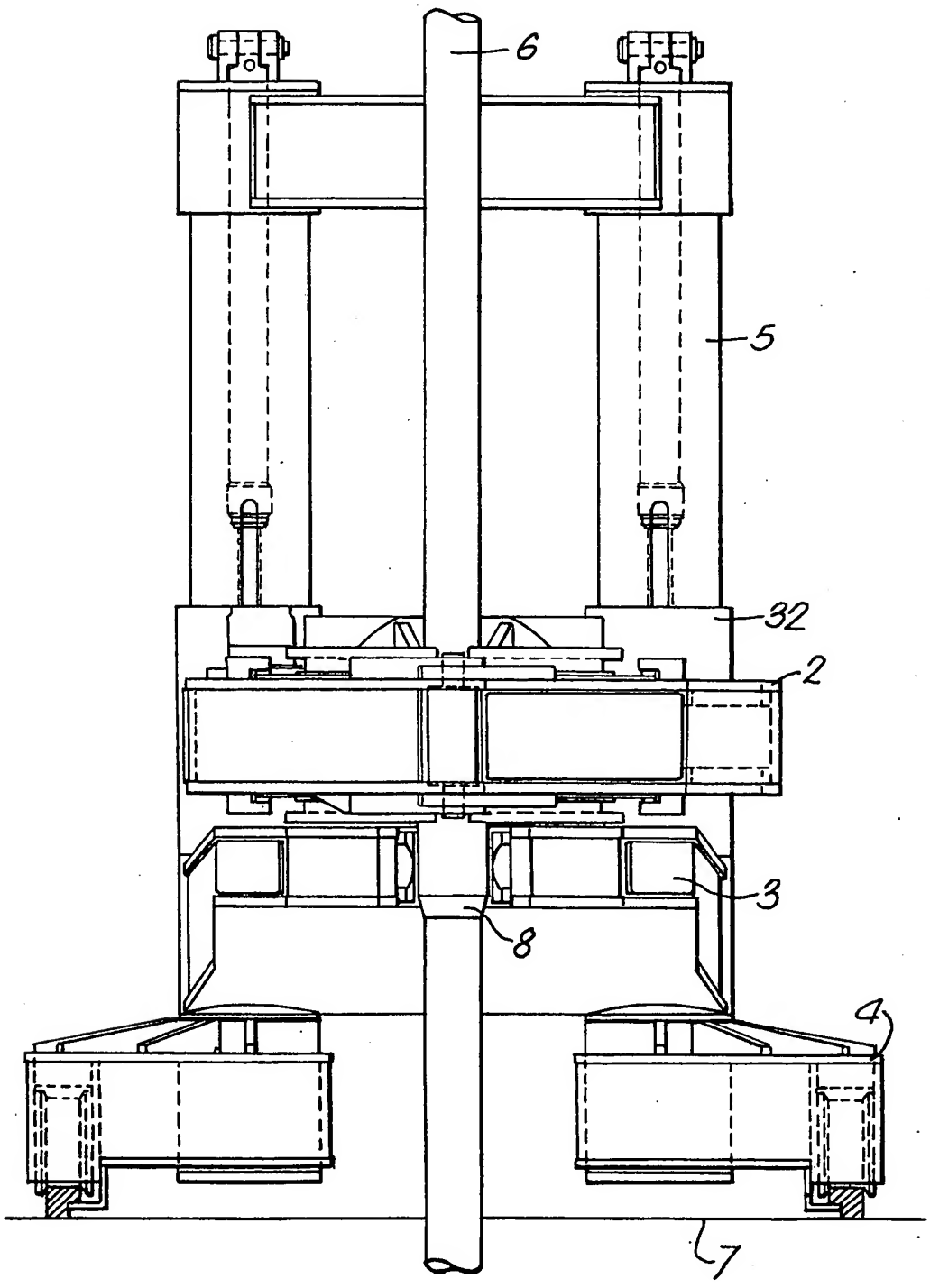


FIG. 6.



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EUROPEAN SEARCH REPORT

Application Number

EP 89 85 0121

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-3 793 913 (WILMS) * Figures 1-5; abstract; column 8, lines 41-46 *	1	E 21 B 19/16
A	US-A-3 748 702 (BROWN) * Abstract; figures 8,9,17,18 *	1	
A	GB-A-1 309 399 (GARDNER-DENVER CO,) * Figure 3 *	1	
A,D	US-A-4 348 920 (BOYADJIEFF)		
A,D	US-A-4 603 464 (SMITH)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

E 21 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21-07-1989	WEIAND T.

CATEGORY OF CITED DOCUMENTS

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